OCES Bulletin 695
OARDC Bulletin 1143
Agdex 110/623

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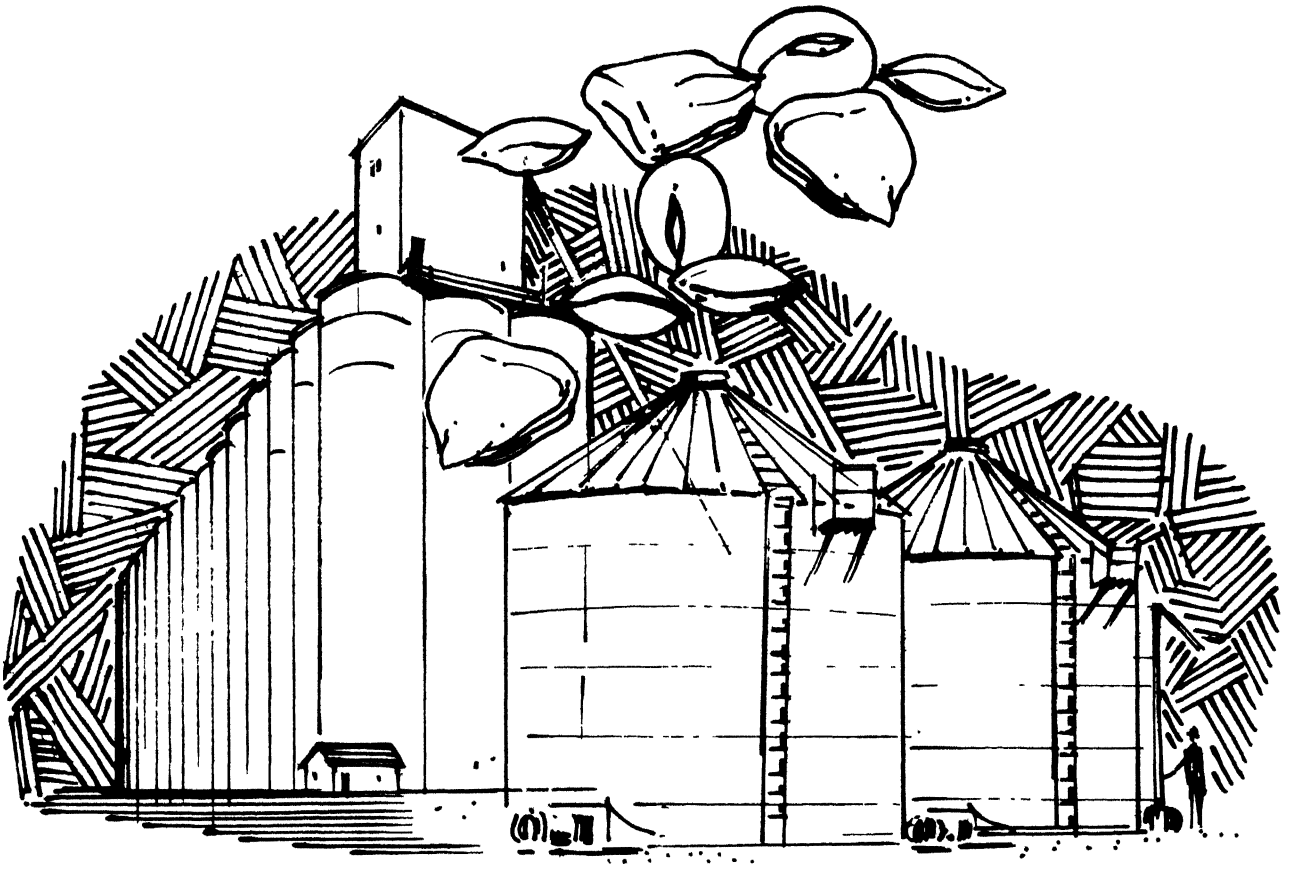
1980



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OHIO COOPERATIVE EXTENSION SERVICE
AND
OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
The Ohio State University

THE USE OF PESTICIDES FOR STORED GRAIN IN OHIO - 1980

Prepared by
Ohio Pesticide Impact Assessment Program

Dr. Acie C. Waldron
State PIAP Liaison Coordinator

Robert L. Curtner and Bruce A. Fingerhut
Technical Assistants

and

Dr. James E. Sargent
Extension Specialist - Stored Grains

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914 in cooperation with the U.S. Department of Agriculture, George R. Gist, Acting Director of Cooperative Extension Service, The Ohio State University.

May 1981

The Use of Pesticides for Stored Grain in Ohio - 1980

Introduction

Ohio is one of the major grain producing states in the United States with 4.15 million acres of corn planted in 1980, 3.8 million acres of soybeans, 1.4 million acres of wheat, 419 thousand acres of small grains (oats, barley and rye), and 15.6 thousand acres of popcorn. As recorded in the OARDC Research Bulletin 1132[1/], Ohio ranked 6th in field corn, soybean and wheat acreage, and 8th in small grain acreage in the North Central Region. The ERS Staff Reports AGES820202[2/] and AGES820106[3/] show that Ohio ranked 6th in the Nation in corn acreage and production and 7th and 6th in soybean acreage and production, respectively, for 1980. Relative to farm marketing cash receipts in Ohio in 1980, soybeans accounted for 25.5 percent of the total ($959,798,000); corn - 20.8 percent ($836,739,000); wheat - 6.7 percent ($253,791,000); small grains - 0.4 percent ($14,303,000); and popcorn - 0.1 percent ($4,444,000).[4/] Grain production in Ohio for 1980 is listed in Table 4.[5/] A considerable percentage of the grain grown in Ohio is utilized for livestock feed. However, Ohio's waterways, particularly the Lake Erie port at Toledo and the Ohio-Mississippi River shipping lanes, also provides opportunity for the transport of grain to other locations. As a result, a considerable amount of grain, domestic and out of state, is stored at sometime during the year.

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[1] "Pesticide Use on Major Crops in the North Central Region - 1978." A. C. Waldron and E. L. Park. Research Bulletin 1132. July 1981, Ohio Agricultural Research and Development Center.

[2] "1980 Pesticide Use on Field Corn in the Major Producing States." M. Hanthorn, C. Osteen, R. McDowell, and L. Roberson. ERS Staff Report No. AGES820202, January 1982.

[3] "1980 Pesticide Use on Soybeans on the Major Producing States." M. Hanthorn, C. Osteen, R. McDowell, and L. Roberson. ERS Staff Report No. AGES820106, January 1982.

[4] "1980 Ohio Farm Income." Department Series E.S.O. 860. Ohio Agricultural Research and Development Center.

[5] "Ohio Agricultural Statistics 1980." Ohio Crop Reporting Service, May 1981. Agdex 100/850.

From the economic and health viewpoints it is important to control pests that could infest stored grain. Major controls can be provided through proper harvesting to avoid shattering or cracking the kernels, correct moisture relationships, proper care of facilities prior to storage of the new crop, and proper temperature, moisture and sanitation of facilities after storage. However, there is still the need for consideration of chemical control during storage and transport. The number of chemical pesticides registered for use in stored grain is rather limited partially due to the fact that the stored product is now at the stage for consumption as food or feed. Consequently, pesticide products must be of low toxicity and quickly degradable or be readily dissipated after use or when the grain is exposed to the atmosphere. In an enclosed atmosphere many registered stored grain pesticides are extremely toxic to warm blooded animals and are classified for "restricted use." Some such as carbon tetrachloride, ethylene dibromide, dichlorvos, piperonyl butoxide, etc. are at various stages of review under the RPAR system (Rebuttable Presumption Against Registration) used by the Environmental Protection Agency (EPA) because of the suspected adverse effects upon man and/or the environment. Because insect control is stored grain is critical but the available pesticide tools are limited in number, it is necessary to determine the use of stored grain pesticide products and the subsequent impact of the availability of those materials.

Procedures

A questionnaire (Appendix I) was mailed to grain farmers and elevator operators in Ohio with a stamped return address envelope and request for participation. The mailing list was organized from the Ohio Department of Agriculture (ODA) listings of those commercial and private pesticide applicators that were certified in the stored grain category. Mailings were sent to 1237 of the 2474 private applicators listed and all of the 137 commercial applicators. The listing of elevator operators was obtained from the directory of the Ohio Grain and Feed Association (OGFA) and a survey questionnaire was sent to each of the 735 names that indicated any grain storage capacity. The returned questionnaires were reviewed and edited by employees of the State Pesticide Impact Assessment Program. Follow-up contact was made via telephone when necessary for encouragement on response or to help interpret data.

Results and Discussion

Approximately 35 percent of the survey sample responded to the questionnaire and almost all provided usable information (Tables 1 and 2). The response represents 18 percent of the total ODA farmer-private applicator list, 38.7 percent of the ODA commercial applicator list, and 32.8 percent of the OGFA elevator operator list. The 19 returned surveys that were not usable were due to the recipient not being engaged in any current activites involving growing or treating grain. Some adjustment in the sample response category was necessary (Table 2) due to those recipients that were involved in a phase of the industry other than that for which they were originally listed. This was particularly true for commercial pesticide applicators who were also elevator operators and thus provided useful information about off-farm storage. Because of the possibility of duplication, the data supplied

by those who were identified as commercial applicators only were not added to the totals from the other sources. Likewise, in order to avoid duplication, any data provided by farmer-private applicators relative to off-farm storage were not tallied with the report unless there were indications that those respondents were also elevator operators.

Of the 740 survey recipients who responded to the questionnaire, 86.9 percent (643) indicated that they stored grain (Table 3). This included 90.7 percent of the farmer-private applicators and 92.7 percent of the elevator operators. Commercial pesticide applicators did not store grain unless they were also farmers or elevator operators. In such cases the data is reported in those categories. Of all those who stored grain, 42.5 percent treated grain and 24.6 percent treated storage facilities for pest control (Tables 3 and 5).

Table 4 lists the data for grain production in Ohio for 1980 and also an estimation of that which has reported in storage at some time during the year as extracted from the Ohio Crop Reporting Service (CRS) publications. Grain storage was calculated by considering the amount reported as in storage for January 1, 1980, evaluating the changes in stocks as reported in the OCRS quarterly reports and adding any increases noted, and adding the change in storage quantities as noted in the quarterly report immediately following harvest from that quarterly report preceding the harvest. This calculation, however, does not take into account any grain received, stored for a short period of time, and then moved out between the quarterly reporting dates. Some elevator operations act mainly in the receiving and shipping of grain and may have only minimal amounts that would be considered as held for storage for any length of time. Another consideration is that some of the grain reported as stored in commercial elevators may originally have been reported as stored on-farm or may have previously been stored in another elevator. Thus the quantities of grain storage indicated in Table 4 are rough estimates but are the best totals available at present.

The capacity of storage facilities for on-farm and off-farm grain storage was based on the total for each grain crop in storage. This appeared to be the only way to calculate the capacity for on-farm storage. The January 1, 1981 quaterly report from the OCRS gave an estimate of 278,166,000 bushels capacity for commercial storage and the OGFA directory indicated a total of 312,148,000 bushels capacity for that membership which consists most of commercial enterprises. However, no other data were available to indicate the breakdown of commercial storage facility capacity to the separate grain crops so the same basis for calculation was used for off-farm as for on-farm. The difference between the totals for commercial storage capacity and the totals for grain in storage is not too great (Table 5).

In terms of total grain production in Ohio, the majority of grain handlers on-farm and off-farm were involved in storing corn, soybeans, and wheat. Seventy-two percent of the stored corn was in on-farm storage according to OCRS statistics, whereas 46.9 percent of stored soybeans, 15.9 percent of the stored wheat, 62.4 percent of the stored oats, and 96.6 percent of the stored barley were on-farm. However, it should be noted that the response to the survey gave a much higher representative sample of the off-farm storage being reported than for on-farm storage (Table 5). Only 10.6 percent

of those who stored corn on-farm treated the grain for pest control, whereas 22.6 percent treated the facilities prior to storing grain. By contrast, 51.1 percent of those who stored corn off-farm treated the grain and 24.4 percent treated the facilities for pest control. Of the total quantity of stored corn only 8.4 percent of the on-farm and 4.9 percent of the off-farm storage were treated for pest control and 27.3 percent and 3.5 percent of the storage capacity, respectively, were treated.

Only a small percentage of the soybeans in storage was treated for pest control. However, a high percentage of the stored wheat required treatment to control storage pests. Approximately 84 percent of the stored wheat was in commercial facilities and 71.2 percent of the elevator operators who stored wheat treated it for pest control with 59.4 percent of that wheat being treated. Thirty-nine percent of those who stored wheat on-farm treated 45.5 percent of it for pest control (Table 5) and 30.1 percent treated 35.8 percent of the storage capacity prior to filling it with wheat. Approximately 12.7 percent of the oats stored in off-farm facilities and 18.7 percent of that stored in on-farm facilities were treated for pest control with about half that much of the storage facilities being treated. Storage of popcorn was only reported for on-farm facilities and 71.9 percent of that in storage and 68.5 percent of the storage facilities were treated with pesticides (Table 5). Many off-farm survey respondents indicated that they treated grain as it came into the elevator as a preventive measure and seldom treated the facilities. By contrast, a larger percentage of on-farm operators treated the facilities prior to filling with grain. Many operators, on-farm and off-farm, based their need to treat stored grain on visual observation of pest infestations. The data revealed that only 10.2 percent of the on-farm and 15.0 percent of the off-farm stored grain in Ohio were treated for pest control in 1980, whereas 26.1 percent of the on-farm and 3.4 percent of the off-farm storage capacity were treated (Table 5).

The majority of farmer-applicators and elevator operators treated the stored grain or the storage facility only once during the year and very few treated more than twice (Table 6). The exceptions were those who stored popcorn where 2 out of the 3 reporting treated the grain twelve times during the year, one elevator operator who treated barley four times, and one elevator operator who treated millet, sorghum and sunflower seed seven times. Table 7 shows that the time of greatest activity in treating stored grain and facilities was associated with a 3-4 month period centered around the harvest season for the crop. As indicated earlier, many survey respondents indicated they treated facilities in preparation for storage, treated grain as it was put into storage, or treated as observation deemed necessary. The data in Table 7 indicates that the period of greatest insect activity or the time that those who store grain are most aware of insect activity is associated with warm weather and/or the time of harvest and one or two months following. The major exception was from those who reported the storage of popcorn where some grain was reported as being treated during every month of the year.

In 1980, approximately 407,650 pounds of pesticide active ingredient (a.i.) were used in treating for stored grain pests (Table 8). Of that total approximately 72.7 percent was used for stored corn, 15.6 percent for wheat, 9.5 percent for oats, 1.4 percent for soybeans and 0.8 percent for popcorn. Carbon tetrachloride was the active ingredient used in the greatest quantity with 292,092 pounds accounting for 71.6 percent of the total pesticide use.

Approximately 76.9 percent of the carbon tetrachloride was used for corn, 11.3 percent for wheat and 10.8 percent for oats (See note 1 and data in Table 8). Relative to the remaining pesticide use, carbon disulfide accounted for approximately 10 percent, ethylene dichloride - 4.2, malathion - 4.2, methyl bromide - 2.8, ethylene dibromide - 2.7, aluminum phosphide (Phostoxin) - 2.2 and sulfur dioxide - 1.1 percent of the total active ingredients. All other chemicals accounted for only 1.2 percent of the total. Carbon tetrachloride, besides being the only active ingredient in some fumigants, is the major constituent of products such as Tetrafume, Tetrakil, Weevilcide, Premium Grain Fumigant, Vertifume, Westofume, and Serafume (Table 9 and 10). It is also a constituent of Grain Conditioner & Weevil Killer, Gas-O-Cide, and Dowfume - 75. Carbon disulfide is a constituent of Tetrafume, Tetrakil, Weevilcide, Premium Grain Fumigant, Vertifume, and Serafume. Ethylene dibromide is a constituent of Tetrafume, Tetrakil, Grain Conditioner & Weevil Killer, Westofume, Gas-O-Cide, and Serafume. Ethylene dichloride is a constituent of Grain Conditioner & Weevil Killer, Westofume, Serafume and Dowfume - 75. Sulfur dioxide is found in Tetrafume, Tetrakil, Premium Grain Fumigant, and Grain Conditioner & Weevil Killer. It can be noted from Table 10 that the major portions of these products were used for on-farm storage. However, the mentioning of these products herein and the listing in Tables 9 and 10 is for information purposes only and does not constitute any endorsement of the product.

Approximately 62.9 percent of the aluminum phosphide (Phostoxin, Detia) was used for insect control in corn with 36.8 percent used for wheat (Table 8). More than 81 percent of the Phostoxin use was for off-farm storage (Table 10). By contrast, 84.2 percent of the methyl bromide was used for insect control in wheat and the remainder for popcorn, but the distribution between on-farm and off-farm use was more evenly balanced at 60 and 40 percent, respectively. Malathion was used mostly for corn, wheat, and soybeans with 42.9, 40.7, and 13.7 percent, respectively. Malathion was used by a greater percentage of grain storers than any other product (Table 10), but approximately 91.6 percent of the total quality was used for on-farm storage. Methoxychlor was used almost exclusively for on-farm storage of corn as was also Bacillus thuringiensis (Dipel) (Tables 8, 9 and 10).

The method by which applicators applied pesticides to stored grain and/or facilities are tabulated in Table 11. It should be noted that the most common method used by the largest percentage of applicators was treatment of the empty bins prior to filling with grain. The next most common method involved spot treatment and pour on procedures after the grain was in storage. However, a significant percent of applicators did apply pesticide to the grain as it was being conveyed into storage and/or fumigated the complete storage facility either before or after the grain was stored. Table 12 shows that 98.1 percent of the application of pesticides to stored grain was done by the farmer/operator or hired employees.

Weevil infestation was the insect problem of most common concern in stored grain in Ohio as reported by survey respondents (Table 13). Many of those who stored grain indicated the use of pesticides as preventive measures but still indicated that weevil infestation was their major concern. The majority of respondents reported that their pesticide application practices resulted in good control of actual or potential pest infestations. The second largest group reported excellent control (Table 14).

Safety practices in storage of pesticides and personal protection of applicators are indicated in Table 15 and 16. Slightly more than 30 percent of those who stored grain on-farm and 81 percent for off-farm indicated that they stored pesticides. It appeared that most of the storage facilities were adequate, but there was utilization for some questionable facilities relative to the safety factor, particularly for on-farm. Questionable facilities included such sites as in the house, basement, and/or garage and in farm shops, tool sheds, and old vacant farm buildings. The latter farm building facilities may be adequate depending upon the status of the building and the separation and security provided. Elevator operators generally had more conventional facilities available because of the overall operational layout, but there were some who kept the pesticides in the office or basement of the elevator building.

Personal safety by use of a gas mask was reported by 39.6 percent of the elevator operators and 30.1 percent of the farmer-private applicators (Table 16). The type of operation and pesticide used does determine the need for the protective gas mask. The data would indicate that many who treated stored grain are not as concerned about personal safety as perhaps they should be, especially when involved with fumigating. Grain handlers do need to be more safety conscious during the treatment of stored grain.

Table 1. Response of Sampling Population to Survey Questionnaire

POPULATION	Sample Numbers		Questionnaire Returned		
	On List	Contacted	Number	Percent	Percent of Population
Private Applicator (Grain Farmer)	2474	1237	446	36.1	18.0
Commercial Applicator	137	137	53	38.7	38.7
Elevator Operator	735	735	241	32.8	32.8
Totals	--	2109	740	35.1	--

Table 2. Adjustment to Sample Population Due to Survey Response

POPULATION	Number of Surveys		Change in Sample[b]		Adjusted Sample Number
			From Returned Surveys		
	Returned	Not Valid[a]	Lost	Added	
Private Applicator (Grain Farmer)	446	7	2	5	442
Commercial Applicator	53	2	35	2	18
Elevator Operator	241	10	6	36	261
Totals	740	19	--	--	721

a - No longer in production or in business

b - Due to changes in response to designated survey which indicated that many on the commercial applicator list were elevator operators, but not included on the OGFA Directory list.

Table 3. Sample Population Engaged in Stored Grain Treatment Activities.

POPULATION	Number Responding Who:					
	Total Sample	Stored Grain	Treated			
			Grain Only	Facilities Only	Grain and Facilities	Total
Private Applicator (Grain Farmer)	442	401[a]	38	66	40	144
Commercial Applicator	18	--	10	--	--	10
Elevator Applicator	261	242	146	13	39	198
Total	740	643	194	79	79	352

a - An additional 21 Private Applicator-Farmers reported off-farm grain storage only.

Table 4. Grain Production and Storage in Ohio - 1980.

CROPS	Grain Production In Ohio		Grain Storage-1980[b]	
	1979[a]	1980[a]	On-Farm	Off-Farm[c]
	(1000 bushels)		(1000 bushels)	
Corn	417,450	440,700	416,552	161,599
Soybeans	145,080	135,360	93,607	106,161
Wheat	63,360	67,130	10,552	56,022
Oats	23,800	19,430	16,981	10,241
Barley	468	416	424	15
Rye	240	231[d]	152	--
Popcorn	680[d]	782	--	--
Total	651,078	664,049	538,268	334,038

a - As reported in "Ohio Agricultural Statistics 1979 & 1980" Ohio Crop Reporting Service - May 1980 and 1981. Agdex 100/850.

b - Calculated from Quarterly Reports 1980 of "Ohio Grain Stocks" Ohio Crop Reporting Service. Calculations based upon stocks reported on January 1, 1980 and the quarterly report following harvest in 1980 and disappearance or increase in stocks with each quarterly report. This may not account for all intake and out-go changes at elevator storage that are involved in trafficing grain shipments, etc., between the dates of the quarterly report.

c - Include any on-farm grain storage transferred to off-farm in sales or crop movement. Thus possible duplication with some on-farm storage amounts.

d - Reported as 44,220,000 and 50,820,000 pounds respectively.

Table 5. Percent of Grain Stored and Treated with Pesticides as Related to Commodity.

CROP	Percent of Total Grain Producers & Elevator Operators Who Stored Grain		Quantity of Grain Commodity Stored				Percent of Those Who Stored Grain Who Treated Grain or Facilities with Pesticides				Percent of the Stored Grain and Facilities that were Treated with Pesticides			
			Reported by Survey Respondents		State Totals from OCRS Statistics		Grain		Bins		Grain		Bins	
	Producers On-Farm [a]	Operators Off-Farm [a]	On-Farm (1000 bushels)	Off-Farm (1000 bushels)	On-Farm (1000 bushels)	Off-Farm (1000 bushels)	On-Farm	Off-Farm	On-Farm	Off-Farm	On-Farm	Off-Farm	On-Farm	Off-Farm
Corn	89.8	74.4	6967.5	131,583.5	416,552	161,599	10.6	51.1	22.6	24.4	8.4	4.9	27.3	3.5
Soybeans	66.5	65.7	1759.2	53,524.9	93,607	106,161	3.8	5.0	17.3	10.1	1.8	3.2	17.8	2.8
Wheat	34.0	57.4	519.6	47,763.2	10,552	56,022	39.0	71.2	30.1	20.9	45.5	59.4	35.8	3.5
Oats	20.3	64.5	162.1	4,367.3	16,981	10,241	13.6	31.4	11.1	10.9	18.7	12.7	8.4	6.9
Barley	0.3	0.8	0.1	3.5	424	15	d	50.0	d	50.0	d	85.7	d	85.7
Rye	---	0.8	---	0.6	152	d	---	50.0	d	0	d	50.0	---	d
Popcorn	1.0	---	116.8	-----	d	d	75.0	---	50.0	---	71.9	---	68.5	---
Sunflower	0.3	---	0.6	-----	d	d	d	---	d	---	d	---	d	---
Buckwheat	0.3	---	0.3	-----	d	d	d	---	100.0	---	d	---	100.0	---
Spelt	0.3	---	5.8	-----	d	d	d	---	d	---	d	---	d	---
Other [b]	---	0.4	---	19.2 [c]	d	d	---	d	---	d	---	100.0	---	d
Total	90.7 [a]	92.7 [a]	9532.0	237,262.2	538,268 [e]	334,038 [e]	19.5 [f]	76.4 [f]	26.5 [f]	21.5 [f]	10.2 [e]	15.0 [e]	26.1 [e]	3.4 [e]

a. Many respondents stored one or more different types of grain which accounts for percentage difference of crops and total.
b. Includes millet, sorghum and sunflower seed.
c. Reported as 1,250,000 pounds total.
d. No data available or data too insignificant to report.
e. Includes only those crops for which data was available.
f. Data is for the percentage who treated grain and/or storage facilities as indicated in Table 3.

Table 6. Frequency and Repetition of Treating Grain in Storage or Storage Facilities

Number of Times for Treatment per Year	Percent Treating Grain or Facilities (Farmer-Private Applicator/Elevator Operator) 1/, 2/			
	Corn	Soybeans	Wheat	Oats
One	81.2 / 63.4	94.2 / 76.9	76.6 / 66.4	86.7 / 74.1
Two	15.8 / 22.3	5.8 / 7.7	22.1 / 24.5	13.3 / 18.5
Three	1.0 / 6.3	0 / 3.8	1.3 / 5.5	0 / 5.6
Four	0 / 2.7	0 / 3.8	0 / 0	0 / 0
Six	2.0 / 0	0 / 0	0 / 0	0 / 0
Eight	0 / 0.9	0 / 0	0 / 0	0 / 0
Twelve	0 / 4.5	0 / 7.7	0 / 0.9	0 / 1.9

1. Numbers of Farmer-Private Applicators/Elevator Operators responding were: Corn 101/112, Soybeans 52/26, Wheat 77/110 and Oats 15/54.

2. Not included in this data are the responses of one elevator operator who treated barley 4 times; one elevator operator who treated millet, sorghum and sunflower seed 7 times; and three farmer-private applicators was treated popcorn - two treated 12 times and one treated 1 time.

Table 7. Time of Year When Grain and/or Facilities Were Treated for Pests

	Percent Treating Grain or Facilities During Month (Farmer-Private Applicator/Elevator Operator) 1/, 2/			
	Corn	Soybeans	Wheat	Oats
January	0 / 4.8	0 / 5.8	1.1 / 3.6	0 / 2.5
February	0.8 / 3.8	0 / 3.8	1.1 / 1.8	0 / 3.8
March	1.6 / 6.3	0 / 3.8	1.1 / 2.4	0 / 2.5
April	3.2 / 10.1	1.9 / 7.7	2.1 / 0.1	0 / 8.9
May	4.0 / 7.2	1.9 / 3.8	0 / 6.1	0 / 10.1
June	4.8 / 7.2	3.7 / 7.7	12.8 / 3.6	35.6 / 3.8
July	12.0 / 9.1	7.4 / 5.8	38.3 / 26.1	23.5 / 17.7
August	14.4 / 13.5	11.1 / 7.7	19.1 / 17.6	23.5 / 8.9
September	40.0 / 20.7	63.0 / 36.5	19.1 / 20.0	17.6 / 29.1
October	16.0 / 6.7	11.0 / 5.8	3.2 / 3.6	0 / 2.5
November	2.4 / 4.3	0 / 7.7	0 / 2.4	0 / 2.5
December	0.8 / 6.3	0 / 3.8	2.1 / 3.6	0 / 7.6

1. Numbers of Farmer-Private Applicators/Elevator Operators responding were: Corn 125/208, Soybeans 54/52, Wheat 94/165, and Oats 17/79.

2. Does not include response data from one elevator operator who treated barley in January, June, August, and October; one elevator operator who treated millet, sorghum, and sunflower seed seven times at 2 week intervals between June 15th and October 1st; and three farmer-private applicators who treated popcorn in every month of the year.

Table 8. Quantities of Pesticide Chemicals Used on Stored Grain in Ohio - 1980[1/]

Pesticide Chemical	Pounds of Active Ingredient Used on Stored Grain[2/]					
	Corn	Soybeans	Wheat	Oats	Popcorn	Total
Aluminum phosphide	5,467.4	4.0	3,195.9	23.4	--	8,690.7
Bacillus thuringiensis	408.6	3.6	0.2	--	--	412.4
Carbon Disulfide	30,317.2	417.4	4,910.0	4,867.8	--	40,512.4
Carbon Tetrachloride	221,079.5	2,651.2	32,344.8	30,956.7	382.9	287,415.1
Chlordane	--	10.5	--	--	--	10.5
Chloropicrin	1,062.6	--	--	432.7	--	1,495.3
Dichlorvos	2.6	2.3	0.5	--	--	5.4
Ethylene Dibromide	8,965.4	155.8	959.1	921.3	--	11,001.6
Ethylene Dichloride	11,708.3	--	4,478.1	--	706.2	16,892.6
Malathion	7,226.6	2,314.4	6,859.6	275.8	167.3	16,843.7
Methoxychlor	2,174.5	127.9	29.0	48.1	--	2,379.5
Methyl Bromide	--	--	9,368.0	--	1,760.4	11,128.4
Pentane	348.5	4.3	40.0	36.7	--	429.5
Pyrethrin	0.1	--	--	--	--	0.1
Sulfur Dioxide	3,372.7	44.8	471.8	471.8	--	4,361.1
Total	292,133.9	5,736.2	62,657.0	38,034.3	3,016.8	401,578.2

1. Extrapolation to state totals is based upon the quantities of pesticides and stored grains reported by survey recipients in relation to the total quantities of stored grains in the State.

2. Survey respondents also reported use of 14.8 pounds of malathion and 4 pounds of chloropicrin for barley; 564 pounds of carbon tetrachloride, 88.8 pounds of carbon disulfide, 10 pounds of sulfur dioxide, 30.1 pounds of ethylene dibromide and 1.2 pounds of pentane for sorghum, millet, rye, sunflower and sunflower seed; and 4,112.9 pounds of carbon tetrachloride, 646.4 pounds of carbon disulfide, 72.0 pounds of sulfur dioxide, 83.4 pounds of ethylene dibromide, and 444.5 pounds of malathion for treatment of empty bins where no indication of grain storage nor bin capacity was given. These figures cannot be extrapolated to state totals because of insignificant percentage of the sample population reporting and/or the non-existence or insufficient state data upon which to base calculations and comparisons.

Table 9. Volume of Pesticide Products Used on Stored Grain in Ohio - 1980[1/]

Pesticide Product[2/]	Gallons (or Weight*) of Formulation Used on Stored Grain[3/]					
	Corn	Soybeans	Wheat	Oats	Popcorn	Total
Carbon Tetrachloride	1,751.7	--	--	--	--	1,751.7
Chlordane	--	2.7	1.4	--	--	4.1
Chloropicrin	649.8	--	278.0	264.4	--	1,192.2
Dipel[4/]	12,769.6*	112.9*	6.9*	--	--	12,889.4*
Douglas 88 Bin Spray	990.8	54.9	15.2	162.9	--	1,223.8
Douglas Special Mill Spray	2.1	--	--	--	--	2.1
Dowfume 75	--	--	151.7	--	100.4	252.1
Gas-O-Cide	13.8	--	--	--	--	13,8
Grain Conditioner and Weevil Killer	215.8	--	1.9	--	--	217.7
Malathion	1,260.9	410.9	1,224.3	44.5	30.1	2,970.7
Marlate	--	56.0	12.5	--	--	68.5
Methyl Bromide[4/]	--	--	9,368.0*	--	1,760.4*	11,128.4*
Phostoxin[4/]	5,467.4*	4.0*	3,195.9*	23.4*	--	8,690.6*
Premium Grain Fumigant	1,360.2	43.4	808.5	1,190.0	--	3,402.1
Tetrafume	9.918.2	54.2	1,308.5	1,029.4	--	12,310.2
Tetrakil	7,545.9	166.2	828.6	817.3	--	9,358.0
Vapona Pest Strip[5/]	63.0*	54.3*	11.0*	--	--	128.0*
Vertifume	8.3	--	--	--	--	8.3
Weevilcide	250.4	--	121.3	--	--	371.7
Westofume	1,460.8	--	482.6	--	--	1,943.4
Total Gallons	25,428.7	788.3	5,234.5	3,508.5	130.5	35,090.5[6/]
Total Other[4/] (Pounds)	18,237.0[4/]	116.9[4/]	12,570.8[4/]	23.4[4/]	1,760.4[4/]	32,708.5[4/]
Other[5/] (Pest Strips)	63.0[5/]	54.0[5/]	11.0[5/]		--	128.0[5/]

1. Extrapolation to state totals in based upon the quantities of pesticide products and stored grains reported by survey recipients in relation to the total quantities of stored grains in the State.

2. Product listings are only for purpose of reporting the response to the survey and do not constitute any endorsement of the product.

3. Asterisks indicate that the data are reported in pounds whereas all other data are gallons of pesticide product.

4. Recorded as pounds of product formulation.

5. Reported as number of 3.5 oz. pest strips.

6. Survey respondents also reported the use of 2.6 gallons of malathion and 2.4 gallons of chloropicrin on barley; 28.0 gallons of Tetrakil and 28.0 gallons of Tetrafume for sorghun, millet, rye, sunflower and sunflower seeds; and 400 gallons of Tetrafume and 79.3 gallons of malathion for treatment of empty bins where no indication of grain storage nor bin capacity was given. These figures cannot be extrapolated to state totals because of an insignificant percentage of the sample population reporting and/or the non-existence or insufficient state data upon which to base the calculations and comparisons.

Table 10. Percent of Pesticide Products Used for On-Farm and Off-Farm Grain Storage

Pesticide Product	Percent of Operators Who Used the Product		Percent of Product Reported Used for Pest Control in	
	On-Farm	Off-Farm	On-Farm Storage	Off-Farm Storage
Carbon Tetrachloride	1.4	0.6	---	---
Chlorofume	0.7	---	100.0	0
Chloropicrin	---	0.6	0	100.0
Dipel	2.8	0.6	100.0	0
Douglas 88	9.2	2.5	96.6	3.4
Douglas Special	0.7	2.5	77.0	23.0
Dowfume 75	0.7	0.6	88.9	11.1
Gas-O-Cide	0.7	---	100.0	0
Grain Conditioner & Weevil Killer	2.1	---	100.0	0
Holiday Fogger	0.7	---	100.0	0
Larvicide	1.4	6.3	33.3	66.7
Malathion	51.8	23.3	91.6	8.4
Methoxychlor	8.5	1.6	99.8	0.2
Methyl Bromide	1.4	3.7	60.0	40.0
Phostoxin	2.1	16.5	18.8	81.2
Premium Grain Fumigant	9.2	12.6	81.8	18.2
Serafume	---	0.6	0	100.0
Tetrafume	24.1	43.9	67.5	32.5
Tetrakil	7.9	12.6	80.8	19.2
Vapona Pest Strip	2.1	---	100.0	0
Vertifume	1.4	---	100.0	0
Weevilcide	2.1	1.6	93.1	6.9
Westofume	---	0.6	0	100.0
West Vapo-Septa	0.7	---	100.0	0
Total			55.5	44.5

Table 11. Methods of Pesticide Application to Stored Grain and Facilities

Method of Application	Percent of Pesticide Applicators Who Utilized Method (Farmer-Private Applicator/Elevator Operator) [1]					
	Corn	Soybeans	Wheat	Oats	Popcorn	Other[2]
Insecticide Treatment of empty bins	76.5 / 40.6	93.9 / 78.3	54.4 / 33.3	61.5 / 30.5	66.7 / 0	100 / 50
Protectant insecticide during storage process	7.8 / 13.2	2.0 / 13.0	20.1 / 30.7	15.4 / 18.6	66.7 / 0	0 / 50
Complete fumigation of storage facility	9.8 / 8.5	2.0 / 17.4	14.3 / 14.9	15.4 / 8.5	66.7 / 0	0 / 100
Spot treatment, pour-on, etc.	28.4 / 72.6	16.3 / 20.1	42.9 / 57.0	46.2 / 64.4	100.0 / 0	100 / 100

1. Numbers of Farmer-Private Applicators/Elevator Operators responding were: Corn 102/108, Soybeans 49/23, Wheat 77/114, Oats 13/59, Popcorn 3/0, and Other 1/2.

2. Includes barley, buckwheat, millet, sorghum and sunflower seed.

Table 12. Personnel Involved in Applying Pesticides to Stored Grain

Personnel	Percent of Pesticide Applied
Self and/or hired employees	98.1
Commercial Applicators	1.9

Table 13. Reported Insect Problems in Stored Grain for Which Pesticides Were Applied[1/]

INSECT	Percent of Respondents Reporting the Problem[2/, 3/]							
	Corn		Soybeans		Wheat		Oats	
	On Farm	Off Farm	On Farm	Off Farm	On Farm	Off Farm	On Farm	Off Farm
Weevil	69.0	80.4	36.7	28.0	80.6	82.0	88.9	78.0
Indian Meal Moth	9.5	1.9	26.7	4.0	9.7	0.9	11.1	--
Angoumois Grain Moth	1.2	0.9	3.3	--	--	--	--	--
Confused Flour Beetle	--	0.9	--	--	1.6	1.8	--	--
Sawtoothed Grain Beetle	--	--	--	--	--	2.7	--	--
Meal Worm	--	--	--	--	--	0.9	--	--
Bran Bugs	4.8	5.6	--	4.0	3.2	2.7	11.1	1.7
Grain Beetles	1.2	--	--	--	1.6	0.9	--	1.7
Other Moths	3.6	0.9	3.3	--	1.6	0.9	--	--
Other Bugs	4.8	1.9	3.3	--	--	0.9	--	--
Preventive Measures	20.2	19.6	43.3	68.0	11.3	18.0	33.3	22.0

1. Because of the low number of respondents reporting, grains including popcorn, barley, and a combined report of rye, millet, sorghum and sunflower seed are not included. Major insect problems in popcorn were weevil and Angoumois grain moth while weevil occurred in the other samples.

2. The total for each column may exceed 100 percent because some respondents reported more than one insect of concern or treatment for insects as well as preventive treatments.

3. Number of respondents for on-farm/off-farm were: corn 84/107, soybeans 30/25, wheat 62/111, and oats 9/59.

Table 14. Status of Control of Stored Grain Pests from Pesticide Application

CROP	Number of Respondents		Percent of Respondents Reporting Control							
			Excellent		Good		Fair		Poor	
	On Farm	Off Farm	On Farm	Off Farm	On Farm	Off Farm	On Farm	Off Farm	On Farm	Off Farm
Corn	89	108	31.5	31.5	60.7	59.3	4.5	9.3	3.4	--
Soybeans	34	21	35.3	42.9	58.8	57.1	2.9	--	2.9	--
Wheat	69	110	37.7	37.3	46.4	55.5	10.1	6.5	5.8	0.9
Oats	11	58	45.5	25.9	54.5	67.2	--	6.9	--	--
Popcorn	3	0	100.0	--	--	--	--	--	--	--
Other[1/]	1	2	100.0	50.0	--	--	--	50.0	--	--

1. Other includes buckwheat, barley and a combined report of rye, millet, sorghum and sunflower seed.

Table 15. Storage Facilities for Stored Grain Pesticides

	On-Farm Storage	Off-Farm Storage	Total
Number Responding to Storage Inquiry	174	179	353
Number Who Stored Pesticides	53	145	198
Percent Who Stored Pesticides	30.5	81.0	56.1
Storage Facility	Percent Reporting Use of Facility[8]		
Warehouse or Elevator Building[1]	3.8	49.0	36.9
Separate Storage Building	24.5	12.4	15.7
Chemical Storage Room[2]	15.1	22.8	20.7
Retail Store[3]	--	8.3	4.2
Locked Cabinet or Container[4]	15.1	6.2	8.6
Farm Shop and/or Tool Shed[5]	13.2	--	3.5
Seed and Fertilizer Building[6]	3.8	3.4	3.5
General Store Room	--	1.4	2.0
Elevator Office or Basement	--	5.5	4.0
General Farm Building	1.9	--	0.5
Vacant Farm Buildings[7]	15.1	--	4.0
Barn	7.5	--	2.0
Granary[6]	9.4	--	2.5
House, Basement, and/or Garage	9.4	--	2.5

1. Respondents generally indicated separation of pesticides from other materials in the warehouse.

2. Storage room associated with other buildings but generally designated for pesticide storage and secured.

3. Some elevator operators used materials from their retail store.

4. Locked cabinet or container located in several of the other facilities.

5. Did not indicate separate storage nor security.

6. Stored in same building but separate from other materials.

7. Buildings include old barns, chicken coup, vacant house, old garage, old milkhouse, milk cooler, etc.

8. May total more than 100 percent because some respondents indicated more than one facility used for storage.

Table 16. Utilization of a Protective Gas Mask When Treating Stored Grains

Application Procedure	Elevator Operators			Private Applicators-Farmers			Commercial Applicators			All Applicators		
	Number Responding	Use of Gas Mask[1]		Number Responding	Use of Gas Mask[1]		Number Responding	Use of Gas Mask		Number Responding	Use of Gas Mask[1]	
		Yes (percent)	No (percent)		Yes (percent)	No (percent)		Yes (percent)	No (percent)		Yes (percent)	No (percent)
Fumigation	113	40.7	57.5	40	30.0	67.5	6	66.7	33.3	159	39.0	59.1
Spraying with other chemicals	27	25.9	66.7	90	25.6	68.9	-	--	--	117	25.6	68.4
Fumigation and other chemicals	20	50.0	45.0	16	56.3	43.8	-	--	--	36	52.8	44.4
No designation of procedures or chemicals used	4	50.0	50.0	--	--	--	-	--	--	4	50.0	50.0
TOTAL	164	39.6	57.3	146	30.1	65.8	6	66.7	33.3	316	35.8	60.8

1. The sum of the yes and no response do not equal 100 percent because some respondents failed to indicate the use status of the gas mask.

OSU/OARDC OHIO STATE PESTICIDE IMPACT ASSESSMENT PROGRAM
THE OHIO STATE UNIVERSITY
1735 NEIL AVENUE
COLUMBUS, OHIO 43210
PHONE: (614) 422-7541

Special Survey of Pest Control for Stored Grain

Dear Sir:

The control of pests in stored grain is vital to providing usable and/or marketable product. The future availability of satisfactory chemical control agents, particularly the fumigants, is questionable due to the EPA registration review process. It appears likely that products containing Ethylene Dibromide (EDB) will be severely restricted for use in stored grain fumigation. Other fumigants such as Carbon Disulfide and Carbon Tetrachloride are now being reviewed and could logically be subject to severe restriction. If we are to provide significant input on benefits, uses, needs, etc. of pesticides for control of stored grain pests, especially the fumigants, and to have a positive effect upon the registration review process (RPAR), it is imperative that we have reliable current use data that will help establish the essential need of such chemical products. Consequently, we request your voluntary help in determining current needs and uses in our attempt to keep pesticides available for use when needed. Your individual report will be kept confidential and used only in combination with other reports to develop a state use summary. Please return your answered questionnaire as quickly as possible (preferrably within the next 2-3 weeks) in the self-addressed, stamped envelope provided. Thankyou for your response.

James E. Sargent
Extension Specialist, Stored Grain
Ohio Cooperative Extension Service

Acie C. Waldron
State Liaison Representative
Ohio Pesticide Impact Assessment Program

Instructions for Completing Questionnaire

1. All information in the survey covers pesticide use for grain storage from January 1, 1980 to December 31, 1980.
2. Please answer Questions 1 and 2 even if you did not treat any stored grain. Check your type of operation in Question 1. If you identify with more than one designation, please provide separate information for Questions 3 through 8 for each category as a farmer, an elevator operator, and/or commercial applicator. (You may duplicate the questionnaire, request an additional copy from Dr. Waldron, or provide specific information on another sheet of paper).
3. If you are a commercial pesticide applicator please provide information on all grain that you treated by contract or agreement for someone else. If, however, as a commercial pesticide applicator, you also have stored grain of your own or are employed at a commercial grain elevator please report separately that grain treated for other growers or elevators versus that grain owned by yourself and/or controlled by the elevator where you are employed.
4. If you treated stored grain as indicated in Question 3a, please provide the information requested in Question 3 through 6 for that crop. If you did not treat a particular crop, enter 0 and go to the next crop.
5. If you don't know the exact bushels on Question 2 or 3, please enter your best estimate.
6. For Question 3b, record the name of each pesticide formulation or product used and the quantity of formulation in gallons or pounds used during the year. Please specify gallons or pounds. (If you provide the name of the product and the amount used, we can calculate the quantity of active ingredient).
7. If you were responsible for, supervised, or involved in the actual application of fumigants or other stored grain pesticides, please answer Questions 8 and 9.
8. A partial list of stored grain pesticides (fumigants and other chemicals) is printed on the back of this questionnaire for your convenience in answering Question 3b.
9. If you have any questions, please contact either Dr. James E. Sargent at (614) 422-5274 or Dr. Acie C. Waldron at (614) 422-7541.

	CORN	SOYBEANS	WHEAT	OATS	BARLEY	RYE	OTHERS (popcorn, sorghum, etc.) please designate
1. Are you a Grain Farmer?_____ an Elevator Operator?_____ or a Commercial Applicator?_____							
2. What was the quantity of stored grain in your operation in 1980?	(BUSHELS)	(BUSHELS)	(BUSHELS)	(BUSHELS)	(BUSHELS)	(BUSHELS)	(BUSHELS)
a. On-Farm Storage	_____	_____	_____	_____	_____	_____	_____
b. Commercial Elevator Storage	_____	_____	_____	_____	_____	_____	_____
3. Stored Grain							
a. How many bushels of stored grain did you treat during 1980 with:							
1. Fumigants	_____	_____	_____	_____	_____	_____	_____
2. Other chemical pesticides	_____	_____	_____	_____	_____	_____	_____
b. What were the names and quantities of pesticide formulation or products used in 1980? (See back of questionnaire for list of products)	Pesticide/Amt.	Pesticide/Amt.	Pesticide/Amt.	Pesticide/Amt.	Pesticide/Amt.	Pesticide/Amt.	Pesticide/Amt.
	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____
	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____
	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____
	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____	_____ ____
c. How many times and what months was the grain treated during the year?	Fumigant/other	Fumigant/other	Fumigant/other	Fumigant/other	Fumigant/other	Fumigant/other	Fumigant/other
	_____	_____	_____	_____	_____	_____	_____
	mos._____	mos._____	mos._____	mos._____	mos._____	mos._____	mos._____
d. What were the methods of application? 1. Insecticide treatment of empty bins. 2. Protectant Insecticide during storage process. 3. Complete fumigation of stored grain facility. 4. Spot treatment, pour-on, etc.	_____	_____	_____	_____	_____	_____	_____
4. How was the application made?							
1. By self (including hired hands)	_____	_____	_____	_____	_____	_____	_____
2. By commercial applicator	_____	_____	_____	_____	_____	_____	_____
5. What were the insect problems for which the pesticide applications were made?	_____	_____	_____	_____	_____	_____	_____
6. How effective was the treatment? (Excellent, Good, Fair, Poor)	_____	_____	_____	_____	_____	_____	_____

7. Was a gas mask used during application? Yes_____ No_____

8. Did you store grain fumigants and pesticides? If so, where? Yes_____ No_____ Where_____

PARTIAL LISTING OF 1980 OHIO REGISTERED INSECTICIDES AND FUNGICIDES FOR POST HARVEST GRAIN PROTECTION
(Trade Names)

Trade Names	Some Major Manufacturers or Formulators
Amoco Methoxychlor Spray	Amoco Oil
Amoco Malathion Spray	Amoco Oil
Cargill Malathion 57%	Cargill
Ortho Grain Fumigant (73)	Chevron
Crown Malathion 57	Crown
Douglas Tetrafume	Douglas Chemical
Douglas Tetrakil	Douglas Chemical
Douglas Special Mill Spray	Douglas Chemical
Douglas "88" Improved Farm Bin Spray	Douglas Chemical
Douglas Grainkote	Douglas Chemical
Dowfume MC-2	Dow
Dowfume 75	Dow
Methyl Bromide	Dow
Vertifume	Dow
Dowfume EB-15	Dow
Dawson 73 Fumigant	Ferguson Fumigants
Dawson 37 Fumigant	Ferguson Fumigants
Dawson 100 Fumigant	Ferguson Fumigants
Chlor-O-Pic	Great Lakes
Meth-O-Gas	Great Lakes
Brom-O-Gas	Great Lakes
E-Z Flo Cythion	Grower Service
Hopkins Methoxychlor E.C.	Hopkins, others
Hopkins Malathion 57% E.C. Insecticide B	Hopkins, others
Malathion Grain Protectant	Industrial Fumigants
Gas-O-Cide Liquid Gas Fumigant	Midland Laboratories
914 Weevil Killer	PBI/Gordon
Mill & Farm Bin Spray	PBI/Gordon
Phostoxin New Coated Pellets	Phostoxin, Degesch
Phostoxin Coated Pellets	Phostoxin, Degesch
Phostoxin Coated Pellets-Prepac	Phostoxin, Degesch
Malathion 55 Insecticide	Platte
Max Kill High Life	Research Products
Max Kill Malathion 57	Research Products
Max Kill Spot 59	Research Products
Max Kill PPB 5	Research Products
Detia Gas-Ex-B	Research Products
Detia Tablets	Research Products
Detia Pellets	Research Products
Vapona (DDVP)	Shell
Vapona Farm Strip Insecticide	Shell
Chlorpicrin 100	Soweco
Larvacide 100	Soweco
Grain Conditioner & Weevil Killer	Thompson-Hayward
Malathion Grain Spray	Unico, others
Malathion Grain Protectant	Unico, others
Grain Fumigant Premium	Unico
Pest master Methyl Bromide	Velsicol
Formula 82-H (FC-14) Grain Fumigant	Vulcan
Terminal (FC-15) Grain Fumigant	Vulcan
Chlorofume (FC-30) Grain Fumigant	Vulcan
Weevil-Cide	Weevil Cide
Weevil-Cide Toxi-Fog	Weevil Cide
Westicide	West
West Insecticide	West
Westfume	West
Pyrethrins	Several companies